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BASE INTRUSION SCHOTTKY BARRIER IR ASSESSMENT CAMERA STUDY.(U)
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Interim Report
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BASE INTRUSION SCHOTTKY BARRIER IR ASSESSMENT CAMERA STUDY

RCA/Government Systems Division

M. J. Cantella

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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APPROVED: Richard W. Taylor

RICHARD W. TAYLOR
Project Engineer

APPROVED: Freeman D. Shepherd

FREEMAN D. SHEPHERD, JR.
Acting Director, Solid State Sciences Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

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For military base perimeter protection, sensors are being developed and deployed to provide an alarm for intrusions. These alarm systems can also provide some level of target classification, but the need to display imagery for human assessment of most target threats following an alarm is a well recognized requirement. This assessment must be accomplished with minimum delay and under both day and night illumination conditions. At night, it is desirable to avoid the use of artificial illumination,

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and the use of the IR spectrum for passive imaging holds great promise. Excellent IR imagery is possible with certain current equipments, but their cost has been prohibitive for deployment in perimeter defense applications. IR focal plane array (FPA) development is progressing, and this approach shows promise for significant cost reductions and increased reliability because of elimination of the need for mechanical scanning.

This program is directed toward evaluation of the use of Schottky barrier technology for base security applications. Emphasis is being placed on the target assessment role, and the use of assessment cameras will also be considered in conjunction with Schottky barrier intrusion detection line sensors.

The program includes coverage studies to determine requirements for array size and camera complexity to provide cost-effective coverage of base perimeters. Considerations include: intruder size, motion, and thermal characteristics as well as fence geometry requirements. In addition, hardware studies are being conducted to determine design requirements and specifications for development and for future field testing of an Advanced Development Model Assessment camera.

Additional studies include optimization of the camera/display interface so that maximum thermal intelligence can be displayed, to human observer, without delay or display adjustment. Alternative scan conversion techniques are being considered for those array configurations which are not directly TV compatible.

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INTRODUCTION AND SUMMARY

For military base perimeter protection, sensors are being developed and deployed to provide an alarm for intrusions. These alarm systems can also provide some level of target classification, but the need to display imagery for human assessment of most target threats following an alarm is a well recognized requirement. This assessment must be accomplished with minimum delay and under both day and night illumination conditions. At night, it is desirable to avoid the use of artificial illumination, and the use of the IR spectrum for passive imaging holds great promise. Excellent IR imagery is possible with certain current equipments, but their cost has been prohibitive for deployment in perimeter defense applications. IR focal plane array (FPA) development is progressing, and this approach shows promise for significant cost reductions and increased reliability because of elimination of the need for mechnical scanning.

Since the early 1970s, RCA has been actively engaged in the development of IR Schottky barrier line and area FPAs for the Air Force RADC Deputy for Electronic Technology, Hanscom AFB. This array technology: operates in the 1 to 5 μm band, uses monolithic silicon construction, and provides excellent sensitivity and dynamic range in real time and with no uniformity compensation. Successful tests and demonstrations of 25 x 50 and 32 x 64 element cameras were made at RADC (Hanscom and Rome), NV and EO Lab, NADC, ONR, NRL, NWC, MICOM, Englin AFB, and WPAFB. Arrays of 64 x 128 and 160 x 244 elements are now under development. The potential for growth to full 525 line TV resolution within the next few years based on the silicon technology employed is very promising. RCA also has under development, on a contract with RADC, a 1 x 256 element line sensor for intrusion detection.

This program is directed toward evaluation of the use of Schottky barrier technology for base security applications. Emphasis is being placed on the target assessment role, and the use of assessment cameras will also be considered in conjunction with Schottky barrier intrusion detection line sensors.

The program includes coverage studies to determine requirements for array size and camera complexity to provide cost-effective coverage of base perimeters. Considerations include: intruder size, motion, and thermal characteristics as well as fence geometry requirements. In addition, hardware studies are being conducted to determine design requirements and specifications for development and for future field testing of an Advanced Development Model Assessment camera.

Additional studies include optimization of the camera/display interface so that maximum thermal intelligence can be displayed, to a human observer, without delay or display adjustment. Alternative scan conversion techniques are being considered for those array configurations which are not directly TV compatible. During this reporting period, work was initiated to establish base security requirements, and the majority of the study effort will be accomplished during the next period.

To provide technical depth to the studies, breadboad camera circuits are being fabricated for operation of the 32 x 64 and 64 x 128 Schottky barrier arrays. Special features have been incorporated to provide automatic operation with good display under varying conditions of thermal environments. These features include automatic black-level control, video amplitude compression, and display spot-wobble. After test of these circuits by RCA, they will be delivered for evaluation by the Government with Government-owned array/dewar/optics hardware. During this reporting period, the camera design was completed and all circuit boards and chassis components were fabricated. Wiring is being completed and integration and check out of the camera will be accomplished in the near future.

SECTION I
SCHOTTKY BARRIER FPA CAMERA BRASSBOARD

1.1 FUNCTIONAL CAPABILITY AND PACKAGING CONCEPT

Breadboard circuits are being fabricated for quantitative assessment of recently designed 32 x 64 and 64 x 128 Schottky barrier arrays as well as for investigation of desirable camera and display operating modes. After test by RCA, these circuits will be delivered for further evaluation by the Government.

A block diagram of the IR camera electronics is shown in Figure 1-1. The camera electronics are designed to operate with either the 32 x 64 or the 64 x 128 focal plane arrays by a simple change of board jumper connections on the synchronizer and the video processor boards in the camera electronics box. The lens, cooler, and focal plane array assembly (not supplied) are shown located on the same mounting plate as the camera head electronics.

The camera head electronics, consisting of the A, B, and C clock generators, the video preamp, and the voltage adjustment panel, have been located as close as possible to the focal plane array to minimize noise pickup and to reduce the number of wires from the camera electronics box to the camera head. These electronics are being packaged as discrete components, handwired on Augat type plug-in boards. This packaging technique, although not volume efficient, is versatile since it allows for inexpensive circuit changes that may be required to maximize the performance of the focal plane array.

The camera electronics unit consists of: a synchronizer, a power converter, a video pre-processor, an automatic black-level controller, a video mixer/image compressor, an output video buffer, and vertical and horizontal sweep-voltage generators. The synchronizer is crystal-controlled to produce jitter-free output video. The video pre-processor accepts the video from the camera head preamp and provides a sampled video signal output with an absolute minimum of noise. The automatic black-level control circuit automatically adjusts the pre-processor signal output to a DC level which places the scene background level signal at the black reference setting. An Auto/Manual switch is also provided for manual setting of black level. The video output processor consists of: a video compressor, a video mixer, a filter, and an output buffer amplifier. The logarithmic video compressor is needed to handle the very wide signal dynamic range. The sensitivity control, by varying the input signal to the video compressor, allows for the enhancement of a target with a specific ΔT within an overall scene. The video mixer allows for the summation of mixed blanking with the video signal information. A two-pole video filter is needed to optimize the video bandwidth. The video cutoff frequency is approximately 80 kHz for operation with the 32 x 64 array and 320 kHz for operation with the 64 x 128 array. The video gain control provides for the level adjustment of the composite video output from zero to approximately 3 volts peak-to-peak.

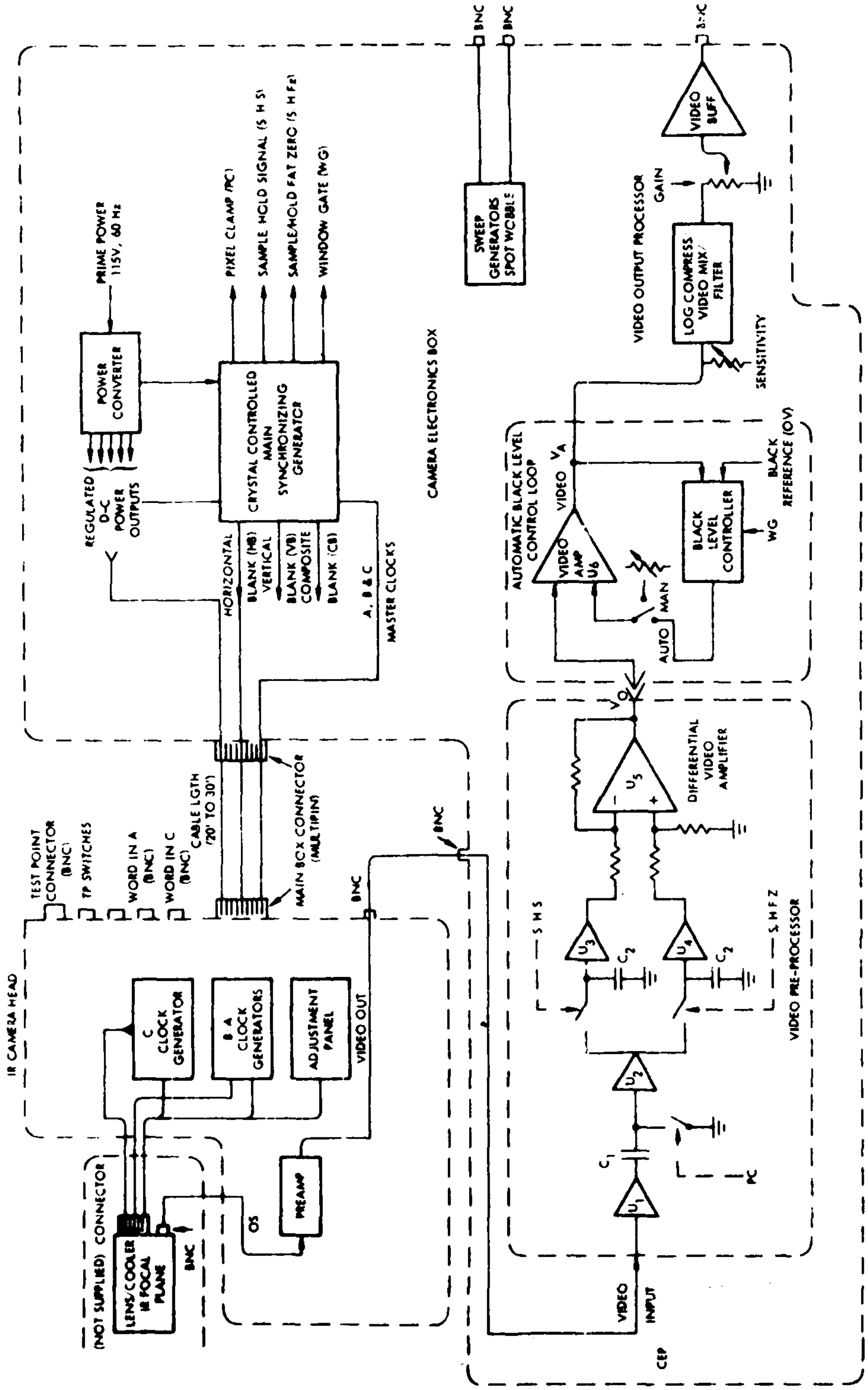

Figure 1-1. Breadboard IR Camera Functional Block Diagram

The packaging of the electronics within the camera electronics box is similar to that of the camera head electronics. The electronics are being packaged as discrete components on Augat type plug-in boards. The power converter is standard Lambda type AC to DC power supply or equivalent. The boards in this box will be mounted in an Augat type rack assembly. The power converter and the rack assembly will be fastened to a subchassis. In addition to the front panel controls shown, LEDs or lamps will be provided for continuous monitoring of all voltage supplies. Horizontal and vertical sync and video outputs will also be available on the front panel for monitoring with an oscilloscope. The back panel contains all the connectors necessary to interface this box with the head and with an external XYZ type display.

1.2 CAMERA HEAD INTERFACE

The camera head electronics are being fabricated for integration with the Government owned lens, dewar/cooler, and Schottky barrier FPA. A drawing of the head electronics box is presented in Figure 1-2. The packaging of the head is similar to that of the electronics box. All adjustments necessary for camera setup with a specific focal plane array are located on the head. Test point monitoring switches are located on the back panel. These switches, in conjunction with a test point connector, allow rapid monitoring of all adjustment voltage levels. Connectors are also provided for insertion of digital words into either the A or C registers. These word insertions are used for initial setup of the A, B, and C registers of the focal plane array. Cable interface connections between the head electronics box and the Government owned dewar/array unit have been established and are listed in Table 1.

To assist the Government in mechanically interfacing the head electronics box with the Government owned dewar/lens assembly, it is planned to furnish a mounting plate. This plate will provide a base for bolting down the head units and will be drilled and tapped for mounting on a tripod.

To assist in future use of the camera in lab and field tests, it is planned to furnish approximately 30 feet of cable for interconnection of the electronics and head units of the camera.

1.3 DEVELOPMENT STATUS

During this interim reporting period, effort has been concentrated on the brassboard camera instrumentation. All materials have been procured and received. All electrical design has been completed including interface with the Government-owned dewar/lens/FPA assembly.

Mechanical design has been completed for the camera electronics and head units. Mechanical requirements for a mounting plate have been established, and design and fabrication of this plate are planned for the next period.

All electronic circuit boards have been fabricated and checked out. Chassis, panels, and brackets for the electronics and head units have been fabricated. Wiring of the electronics unit is approximately 80 percent complete.

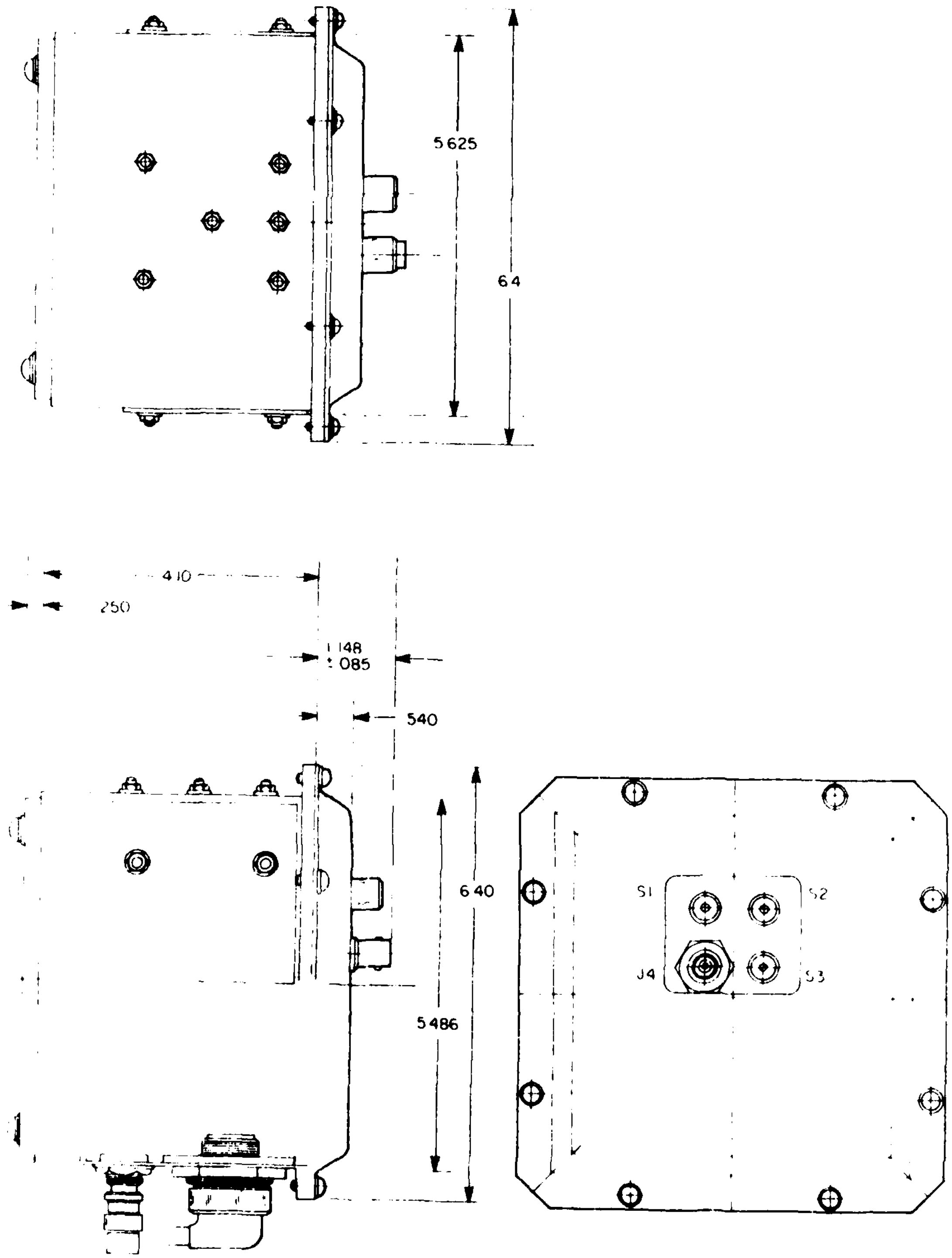

Figure 1-2. Camera Head Electronics Unit

Table 1. Head Electronics Interface Cable Connections - TC1247, 32 x 64 Element FPA

Head Unit Bendix Connector Pin		FPA Function
A		Substrate
B		G_{3A}
C		G_{2A}
D		G_{1A}
E		V_S
F		V_T
G		$\emptyset_{1B}$
H		$\emptyset_{2B}$
J		$\emptyset_{3B}$
K		$\emptyset_{4B}$
L		G_{1C}
M		G_{2C}
N		G_{3C}
P		$\emptyset_{1C}$
R		$\emptyset_{4C}$
S		$\emptyset_{2C}$
T		$\emptyset_{3C}$
U		V_{DD}
V	- Not Connected -	
W		V_{GG}
X		V_D
Y		G_{6C}
Z		G_{5C}
a		G_{4C}
b		$\emptyset_{1A}$
c		$\emptyset_{3A}$
d		$\emptyset_{2A}$
e		$\emptyset_{4A}$
j		Transistor Collector (H2V) (Output)
g		Transistor Emitter

During the next period, it is planned to complete wiring of the electronics and head units and to integrate and test the entire camera system using an RCA owned dewar/lens/FPA assembly. Consultation will be provided to the Government for integration of the camera electronics delivered on this program with the Government owned dewar/lens/FPA assembly.

SECTION 2
STUDIES

2.1 CAMERA COVERAGE

Schottky barrier FPA technology could provide a day/night capability for detection and classification of perimeter intrusions. Both line and area arrays and associated sensor hardware packages have been under development and will be field tested in the near future.

To obtain adequate target assessment coverage, cameras would generally be placed at intervals along a perimeter fence line. The spacing of these cameras would be limited by target recognition performance. This performance is determined by target/background thermal signatures, array and optics performance, and camera field of view. A parametric tradeoff among the mentioned parameters is required to arrive at recommendations for a cost-effective level of camera complexity. During the next period, it is planned to establish the number and complexity of cameras required per length of fence line.

To support this coverage study effort, various data inputs are required which include a definition of intruder size and thermal characteristics as well as a definition of the fence geometry requirements. During this reporting period, an effort was initiated to establish definitions with the assistance and corroboration of the Air Force Technical Monitor. For general background, the following documents were obtained from the Physical Security System Directorate:

(1) "Siting Criteria for Safe Programs", SAFE-SIT-0001, 29 Feb 1980.

(2) "General System Specification for BISS", BIS-SYS-10000A, Code Ident 50464, 31 Mar 1981 (DRAFT).

Another important data input is the resolution (Minimum Resolvable Temperature) performance of current and future Schottky barrier arrays. It is planned to use measured and predicted MRT characteristics for the studies planned for the next period.

2.2 CAMERA/DISPLAY INTERFACE

The Camera/Display Design Studies are being directed mainly toward achievement of adequate day/night sensitivity and resolution with unattended camera operation. In addition, the video from the camera should transfer maximum thermal intelligence to the operator instantly and without display adjustment, regardless of changing ambient conditions in the environment.

The breadboard camera hardware characteristics include automatic black-level control and video amplitude compression. Other display techniques for use with low-resolution IR arrays are sample-hold along each display raster line and either spot-wobble or repeated video perpendicular to each raster line.

Image enhancement circuits are required to preserve on the display the information content associated with the large thermal dynamic range of video scene information. The Schottky barrier sensor video contains scene temperature information which covers a dynamic range of several thousand to one; a CRT display, however, typically has a luminance range of 15:1 to 30:1.

This dynamic range problem is particularly significant because of the requirement for rapid target acquisition following an instrusion alarm.

One method of interest for display dynamic-range compression takes advantage of the eye's image-size-dependent property of threshold perception. Since the eye can detect luminance differentials of only 1 percent over large areas of a display and needs at least a 20 percent differential over very small areas, the dynamic range problem might be solved by making the CRT large-area gain much less than it is for small areas. One promising technique for implementation of large-area/local-area gain adjustment is the use of high-frequency-emphasis spatial filters. Within small contours, the CRT gain is higher to compensate for the lower contrast sensitivity of the eye for small areas. The large-area contours, within which most of the large temperature excursions will generally fall, are displayed at low gain and yet can be resolved because of the higher large-area sensitivity of the eye. It is planned to include in these studies this technique and its practical implementation.

Various scan conversion techniques will also be considered in the studies for those alternative camera designs which are not directly TV-compatible. These techniques would permit use of standard TV monitors, video switching, and magnetic recording equipment and would allow taking advantage of the luminance range of a standard television CRT as compared to a standard XYZ type display. The scan conversion technique chosen must accommodate the large camera signal dynamic range. The technique should also include line interpolation to eliminate the visual blocking effects caused by sampling structure in the vertical direction.

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